

Test Method

Determination of Retroreflectivity of Pavement Markings

RC 424.01

1. Scope

This test method is used to :

- (a) Determine the retroreflectivity of pavement markings; and
- (b) Determine the Average Level of Retroreflectivity of a test lot.

The method applies to pavement markings that include glass beads, either surface applied or embedded within the marking medium.

Note : The method applies to a single test lot. Multiple test lots (eg for centre, edge, lane, arrows, symbols, etc) may be tested concurrently as the roads length is travelled.

2. Apparatus

- (a) Retroreflectometer, a device used to measure retroreflectivity, with entrance angle of 88.76 degrees and observation angle of 1.05 degrees; for example Mirolux Ultra 30 or MX 30.
- (b) Manufacturer's standardization plate
- (c) Operating manual for retroreflectometer.
- (d) Template, aluminium or rigid plastic, of appropriate dimensions (optional).
- (e) Secondary reference plates, traceable to national standards. For example, a boxed set of 4 reference plates, comprising "zero", "low", "medium" and "high" retroreflectivity.

3. Definitions

- (a) Pavement marking – The term used to define linemarking and roadmarking.
Linemarking includes all longitudinal lines such as centre, lane, edge, turn and continuity lines.
Roadmarking includes all transverse lines and markings such as Stop/Give Way lines, pedestrian lines, arrows, chevrons, symbols and legends.
All pavement markings tested using this method include glass beads.
- (b) Retroreflectivity – A property of some materials, such as solid glass beads, to reflect incident light in directions close to the direction from which the light came. Retroreflectivity, the coefficient of retroreflected luminance, is the value of reflected light measured in millicandela / square metre / incident lux ($\text{mcd}/\text{m}^2/\text{lx}$), and is used as a measure of light reflected by pavement markings.

- (c) Test site – The location along a carriageway or road where the retroreflectivity of the pavement marking is measured.
- (d) Retroreflectivity reading – An individual measurement of retroreflectivity.
- (e) Mean Retroreflectivity (MR) – The mean of four individual retroreflectivity readings, taken at four evenly spaced positions over either a 2 to 5 metre length of linemarking, or within 1m^2 of roadmarking, at the test site.
- (f) Site Retroreflectivity Value (SRV) – The adjusted value of retroreflectivity for a test site.
- (g) Average Level of Reflectivity – The average of six test site Site Retroreflectivity Values (SRV) for the Lot.
- (h) Lot – A quantity of pavement markings of the same type (linemarking or roadmarking) that meet the requirements for combination into a single group. Generally, retroreflectivity properties for the lot are determined from measurements made at six test sites.

4. Calibration

Calibration of retroreflectivity equipment shall be in accordance with the following requirements.

4.1. Calibration of secondary reference plates

The secondary reference plates shall be calibrated at intervals not greater than 12 months. Calibration shall be in accordance with AS/NZS 1906 Part 1, Appendix A – *Photometric properties test*. A NATA endorsed report shall be issued for the secondary reference plates indicating plate identification, calibration status and measured value of coefficient of luminous intensity per unit area.

Note: Secondary plates (for example, Roadmarking Industry Association of Australia traceable references) must be kept clean at all times; they may be cleaned in accordance with the manufacturer's specification. Make sure particularly the surfaces are not touched after cleaning.

4.2. Laboratory calibration of retroreflectometer

The retroreflectometer shall be calibrated at intervals not greater than 12 months, or after replacement of a component in the instrument which would affect the calibration. Calibration shall be in accordance with the manufacturer's instructions, against the secondary reference plates calibrated as for Clause 4.1. A calibration report shall be issued indicating retroreflectometer identification, calibration status and calibration constants.

4.3. Reading standardization of retroreflectometer

Before and after taking readings at each test site, the retroreflectometer shall be standardized against the standardization plate provided with the instrument in accordance with the manufacturer's instructions, as described in Clause 6. These standardization readings are used to determine drift and scaling factors in the measurement by the retroreflectometer. The factors are then used to adjust field measurements, as detailed at Clause 7.

The reading standardization shall be repeated if the retroreflectometer is turned off.

5. Lot Selection

5.1. General Principles

Pavement markings (linemarking and roadmarking) shall be tested using lot testing, with lots defined as follows:

(a) Length of a Lot

The length of a Lot within a section of road defined in the road inventory information shall be:

- (i) no longer than 50 km for a road in a Rural Area; and
- (ii) no longer than 10 km for a road in an Urban Area.

(b) Properties of a Lot

Within the maximum length permitted for testing, a section of pavement markings shall be defined as a Lot where the pavement markings have the following properties:

- All lines and markings were completed within 30 days of each other;
- The placement of the lines and markings have uniform material, application and exposure;
- The work being tested is essentially the same line or marking type.

In addition to the above:

- Each edge line shall be considered a separate Lot;
- Each centre line shall be considered a separate Lot and the various types (standard stripe, barrier line) can be combined into a Lot;
- Each lane line shall be considered as a separate Lot;
- Each leg of an Intersection shall be considered as a separate Lot;
- Roadmarkings other than at intersections shall be considered separate Lots; and
- Location of high wear deterioration as defined in (c) below shall be considered as a separate Lot.

Where a Road Section or Intersection does not satisfy this definition of a Lot, the pavement markings shall be split into separate lots for testing purposes, in order to conform to the above definitions.

(c) High wear locations:

Locations of high wear are defined as:

- Curves with lengths of 50m or more and where wear is evident.

Each high wear location shall be treated as a separate (small) lot, with 3 test sites tested along the high wear length. These three values shall be averaged to determine the Average Level of Retroreflectivity for the high wear location Lot.

5.2. Test site selection within specific lot types

Lot Testing shall be carried out as follows:

(i) For single and dual carriageways:

For edgelines, the test sites shall be tested in the direction of travel.

For centrelines and lane-lines, testing at each test site shall be in both directions of travel. The lower of the two directional SRV at each test site shall be used in the calculation of Average Level of Retroreflectivity for the Lot.

(ii) Intersections and roundabouts

For stop lines or pedestrian walk lines, at least two SRV shall be determined in the wheel path, at least two SRV shall be determined on the edge/lane lines and two SRV determined on lane arrows if applicable.

Where there are turn lines through the intersection or roundabout associated with the approach, six SRV shall be taken on the turning lines and lane lines. These results shall be used to calculate Average Level of Retroreflectivity.

Results are to be submitted for all intersection approaches.

6. Procedure

Each test lot shall have six test sites randomly selected and tested. Each test site shall be tested by taking a total of four retroreflectivity readings at evenly spaced positions within a 2 to 5 metre length of line marking, or within 1m² of roadmarking. The four retroreflectivity readings shall be averaged and adjusted to determine the Site Retroreflectivity Value (SRV) for that site. Table 1 provides a worked example to calculate Site Retroreflectivity Value (SRV)

The SRV for each of the six test sites shall be used to calculate the Average Level of Retroreflectivity for the Lot.

6.1. Preparation for testing

- (a) Input the factory calibration factor supplied by the manufacturer into the retroreflectometer.
- (b) Ensure that the retroreflectometer functions correctly before use, and prepare the retroreflectometer for testing in accordance with the manufacturer's instructions.
- (c) Determine the extent of the lot and the pavement marking types applicable to the lot.
- (d) Select the test sites within the lot randomly in accordance with VicRoads Test Method RC316.10 – *Selection of test sites within a test lot*, for selection of longitudinal positions.
- (e) Select the reading positions as evenly spaced over a 2 to 5 metre length of the pavement marking, or within 1m² of roadmarking, at each test site.

6.2. Making Retroreflectivity Readings

- (a) Before taking readings at the test site, the retroreflectometer shall be standardized against the standardization plate provided with the instrument in accordance with the manufacturer's instructions, as follows :
 - Record a reading (B_{before}) from a non-reflective surface (eg. a surface with retroreflectivity reading of 0 mcd/m²/lx) or medium (eg. the sky), and
 - Record a reading (R_{before}) of the retroreflective surface of the standardization plate.
- (b) Record the pavement marking type and the test site location detail.
- (c) Align and centre the retroreflectometer over the line at the test position. A template maybe used to ensure repeatable location of the instrument from one test to the next.
- (d) Record a measurement of retroreflectivity (R_i), in accordance with the manufacturer's instructions.
- (e) Record the readings at the other three positions at the test site.
- (f) After completing the readings at the test site, the retroreflectometer shall be standardized again, as follows :

- Record a reading (B_{after}) from a non-reflective surface or medium (as for step (b) above), and
- Record a reading (R_{after}) of the retroreflective surface of the standardization plate.

- (g) Repeat Steps (a) to (f) at the other test sites in the lot (there may be a significant distance between test sites).

7. Calculations

7.1. Site Retroreflectivity Value

The measured retroreflectivity readings are corrected using the before and after reading standardization values to determine the Site Retroreflectivity Value, as follows :

- (a) Calculate the correction for difference in measurements of the non reflective surface (Average Base Drift, B_{ave}) at each test site, using the following equation:

$$\text{Average Base Drift}(B_{\text{ave}}) = \frac{B_{\text{before}} - B_{\text{after}}}{2}$$

- (b) Calculate the correction for difference in measurements of the retroreflective surface of the standardization plate (Scaling factor, F_s), at each test site, using the following equation:

$$\text{Scaling Factor}(F_s) = \frac{R_{\text{before}} + R_{\text{after}}}{2 R_{\text{before}}}$$

- (c) Calculate Mean Retroreflectivity (MR) as the mean of the individual retroreflectivity readings (R_i) for each test site, using the following equation:

$$MR = \frac{\sum R_i}{4} \quad \text{where } i = 1, 2, 3, 4$$

- (d) Calculate the Site Retroreflectivity Value (SRV) for the test site, using the following equation:

$$SRV = \frac{MR + B_{\text{ave}}}{F_s}$$

- (e) Table 1 provides a worked example to calculate Site Retroreflectivity Value (SRV).

7.2. Average Level of Retroreflectivity

- (a) Repeat Step 7.1 to determine the six results for SRV for the lot,
- (b) Calculate the Average Level of Retroreflectivity for the lot using the six test site SRV, using the following equation :

$$\text{Average Level of retroreflectivity} = \left\{ \sum_{j=1}^n SRV_j \right\} / n$$

where: SRV_j = an individual value of SRV

$j = 1, 2, 3, 4, 5 \text{ \& } 6.$

n = the number of sample points per lot
= 6 for this method, and

Table 2 provides a worked example to calculate Average Level of Retroreflectivity for the lot.

8. Reporting

Report the following information :

- Identification of road(s) or intersections tested;
- Date of test;
- Serial number and calibration report number for retroreflectometer;
- Standardization procedure for the retroreflectometer;
- Location (chainage, direction, offset) of test sites;
- Type of pavement marking (edge, lane or centre lines, intersection approach or turning lines, or individual road markings);
- Individual retroreflectivity readings for the lot, to the nearest $1 \text{ mcd/m}^2/\text{lx}$;
- Average Level of Retroreflectivity for the lot, to the nearest $1 \text{ mcd/m}^2/\text{lx}$;
- Type of substrate (Asphalt, Spray seal, etc);
- Site conditions (dry / wet);
- Identification of the paint and/or beads used in the markings, if known;
- Name of the testing laboratory and the person performing the test; and
- Reference to this test method, i.e., RC 424.01.

Table 1 : Worked Example for adjusting measurements of Retroreflectivity (Ri) to calculate Site Retroreflectivity Value (SRV)

Before Reading on Non-reflective Surface or Medium ($\text{mcd/m}^2/\text{lx}$) (B_{before}) = 0					
Before Reading on Standardization Plate ($\text{mcd/m}^2/\text{lx}$) (R_{before}) = 100					
Measurements of retroreflectivity	R1	R2	R3	R4	
($\text{mcd/m}^2/\text{lx}$)	118.2	127.8	122.6	113.8	
After Reading on Non-reflective Surface or Medium ($\text{mcd/m}^2/\text{lx}$) (B_{after}) = 3					
After Reading on Standardization Plate ($\text{mcd/m}^2/\text{lx}$) (R_{after}) = 114					
Then, Average Base Drift (B_{ave}) = $\frac{0-3}{2} = -1.5 \text{ mcd/m}^2/\text{lx}$					
and Scaling Factor (F_s) = $\frac{100+114}{2 \times 100} = 1.07 \text{ mcd/m}^2/\text{lx}$					
Mean Retroreflectivity (MR) = $\frac{118.2+127.8+122.6+113.8}{4} = 120.6 \text{ mcd/m}^2/\text{lx}$					
Site Retroreflectivity Value (SRV) = $\frac{120.6+(-1.5)}{1.07} = 111.3 \text{ mcd/m}^2/\text{lx}$ <i>round to 111 $\text{mcd/m}^2/\text{lx}$ for reporting</i> <i>use un-rounded for calculating Average</i>					

Table 2 : Worked Example to calculate Average Level of Retroreflectivity

Site Retroreflectivity Value (SRV j) (j = 1 → 6)	SRV 1	SRV 2	SRV 3	SRV 4	SRV 5	SRV 6
(use un-rounded for calculation) $\text{mcd/m}^2/\text{lx}$	111.3	125.4	97.3	104.7	86.8	121.4
Average Level of Retroreflectivity	= $\frac{111.3+125.4+97.3+104.7+89.6+121.4}{6} = 107.8 \text{ mcd/m}^2/\text{lx}$					
Report as: Average Level of Retroreflectivity	= 108 $\text{mcd/m}^2/\text{lx}$, after rounding					

Test Method - Revision Summary

RC 424.01 Determination of Retroreflectivity of Pavement Markings

Date	Clause Number	Description of Revision	Authorised by
December 2012	Full document Clause 3(g) Clause 7.2 Table 2	Re-styled with minor corrections made Changed to define and determine Average Level of Retroreflectivity (replaces Characteristic) Added to provide worked example for calculating Average Level of Retroreflectivity	Principal Advisor – Pavements & Materials